percentage increase of weight after birth occurs in those animals which are born least mature. Thus in the guinea-pig, which is born in a relatively mature state, the daily percentage increment of weight just after birth is 5 per cent., while the rabbit, which is born much less mature than the guinea-pig, daily adds 17 per cent. to its weight. In embryonic life, cellular division and increase in weight are still more marked, and Prof. Minot estimates that 98 per cent. of the original growth power has been lost at birth, and the power of growth becomes less and less as age advances.

Differentiation and rejuvenation of cells are next considered. In the embryo the cells differ but little from one another; they do not display structural differentiation, whereby it could be said from what part of the embryonic body they were derived; while in the adult the microscopic characters of a cell generally suffice to determine its place of origin. Moreover, with the differentiation of cells with age, the protoplasm increases in amount relative to the nucleus. The conception is therefore reached that the growth and differentiation of the protoplasm and relative diminution of nuclear matter are the cause of the loss of the power of growth.

If cells suffer from old age as their protoplasm increases and becomes differentiated, a general and progressive process in the individual, there should be some mechanism for rejuvenation; this the author regards as accomplished by the segmentation of the ovum, during which process an *increase* of nuclear matter takes place at the expense of the protoplasm. The author believes that there is no satisfactory evidence that the progeny of old cells (other than of the ovum) can resume the primitive state and undergo re-differentiation. In cases in which regeneration of excised parts, &c., is effected in the individual, *e.g.* in planarians and ascidians, the regenerated part is always the product of undifferentiated cells, and is not derived by the growth of the old tissues.

The usual method of rejuvenation adopted by nature is by the separation of cells in the primitive and undifferentiated condition, and their isolation as the germ or sex cells. Age then represents the result of a progressive cytomorphosis of which death is the culmination. Longevity, the duration of life, depends, therefore, upon the rate of cytomorphosis, which varies much in different species, and perhaps in different individuals of the same species. Whether rejuvenation can be improved and senescence delayed are questions to which the author gives no definite answer, though he surmises that in the future it *may* be possible to increase the activity of nuclei and prolong the younger system of organisation. Death he regards as acquired during the process of evolution in consequence of cytomorphosis. As organisation becomes higher and higher, the need for differentiation becomes greater; this involves the end, and death is the price we have to pay for the differentiation which exists in us, and to which we owe our great array of faculties!

This, in brief, is the argument of Prof. Minot, which is presented in an attractive form with many appropriate illustrations, and we have perused this work with considerable interest. Finally, a suggestion of some importance is made. The author develops the conception that not only physical but also psychological development is most rapid in early life, and progressively declines as age advances. He suggests, therefore, that the tendency there is in some quarters to postpone the period of learning is wrong, and that as much use as possible should be made of the early years of life. R. T. H.

THE SONGS OF BIRDS.

Kunst und Vogelgesang in ihren wechselseitigen Beziehungen von naturwissenschaftlich-musikalischen Standpunkte beleuchtet. By Dr. B. Hoffmann. Pp. ix+230. (Leipzig: Quelle und Meyer, 1908.) Price 3.80 marks.

THIS is the most interesting book on the songs of birds that has appeared since the late Mr. C. A. Witchell published his "Evolution of Bird-song" in 1896, and it excels that work both in soundness of judgment and in knowledge of music. Its object, however, is not quite the same as that of Mr. Witchell's volume (which does not seem to have fallen into Dr. Hoffmann's hands); the latter was an attempt to trace the development of song from call- and alarm-notes, and also from imitation of natural sounds, while Dr. Hoffmann's work may be described as an essay on the relation between the music of birds and the music of art.

For dealing with this subject the writer is evidently well qualified; he is clearly a close observer of all sounds made by birds in their wild state, and wisely abstains from making use of the music of birds in captivity, and at the same time he is quite at home in the subtleties of the musical art. The result is that we have here no foolish attempt to represent the music of birds on our musical scale, except in a few cases where it is possible to do so as a means of illustrating certain points rather than as an exact reproduction of the notes of the singer. For Dr. Hoffmann is well aware that the great majority of singing birds do not use the intervals of our scale, though he is right in claiming that a few occasionally do so. So, too, in a very interesting section on rhythm in song, he denies that it is to be found in any sense in a great number of songs, while rightly asserting that it is present in those of certain species, such as quail, great tit (Kohlmeise), wood-pigeon, and song-thrush.

In another section (pp. 99–122) he asks the question how the bird comes by a sense of rhythm, and, rejecting Bücher's theory that rhythm in music can be traced to the movements of the body, he is disposed to think that in the case of birds it has its origin in the action of the heart; but this is a delicate question, for which the reader must be referred to the author's own statement of it. Dr. Hoffmann also discusses the question of "Metrik" in bird-song, *i.e.* Can the strains sung by any birds be divided into feet or bars? On p. 84 foll. he maintains that in the song of the nightingale, the most highly

developed singer of all, this quality can be found as well as rhythm and invention. Whether we agree with him or not in some of these details, it is a pleasure to be able to say with confidence that all he writes deserves careful study, for which every conscientious ornithologist will be the better.

The only thing that seems wanting is a discussion of the *quality* of tone (not quantity) in various species. Thus the formal likeness between the songs of the chaffinch and the willow-wren is noticed (p. 31), but nothing is said of the fact that they are produced by totally different instruments. To the ear of the present writer the songs of both species of redstart are "played" on an instrument which no other bird possesses. We would suggest that Dr. Hoffmann should add a section on this subject in another edition, and shorten, if need be, the discussion at the end of the volume on the use made by musical composers of the songs of birds, which is only of incidental interest. Before leaving this interesting work, which well merits translation into English, it may be as well to say that the author is disposed to reject Darwin's theory of the development of song by sexual selection, and to hold that the root of it is to be found in the enjoyment of life and the love of play, especially, but not entirely, in the breeding season. W. W. F.

OUR BOOK SHELF.

The Scientific Aspects of Luther Burbank's Work. By D. S. Jordan and V. L. Kellogg. Pp. xiv+115. (San Francisco: A. M. Robertson, 1909.) Price 2 dollars net.

THIS is a small book, consisting of two papers reprinted from the *Popular Science Monthly*, describing and appreciating the work of the great American plant-breeder. It is attractively illustrated by photographs, and is intended for the general as well as the scientific reader.

Luther Burbank was born in 1849, and after a local education started life in his uncle's plough factory. He soon gave this up for market gardening, and in 1875 moved to Santa Rosa, California, where he has since worked on a large scale, and produced many new and important varieties, both of fruits and flowers. He has discovered no new laws, but his results are so obviously successful that it is interesting to know the methods by which they have been obtained. Like most practical men, he is a firm believer in the heritability of the direct effects of environment, but he makes most use of the indirect ones—the "indefinite variations" of Darwin—and recognises as their chief cause the re-combination of characters consequent on hybridisation, and, in a lesser degree, on cross- or self-fertilisation.

The first step in the method usually followed is the inducing of these variations by nutritive changes or by the crossing of forms as widely separated as is compatible with fertility. The useful variations are then accumulated by stringent selection until they become fixed. Mr. Burbank finds that six generations are generally sufficient to accomplish the process. He holds that there is practically no limit to the results which can be obtained by unassisted selection, and many of his size and colour varieties of flowers have been obtained by this method alone. Sometimes, on the other hand, a new variety is produced by the careful propagation, without much selection, of one individual which showed a fortunate mutation. The Burbank stoneless plum is an example of the effective combination of the three processes of searching for natural mutations, hybridising, and selection. A plum was found in a small wild species with only part of a stone. This species was crossed with the French prune, and some of the offspring found to be quite stoneless. Further selection is still increasing the proportion of stoneless, and at the same time large, fruits. The desirable qualities of two varieties can generally be combined by crossing; indeed, some of the offspring often possess a quality in a higher degree than either of their parents. Some of the photographs illustrating the increase of size in fruits show this in a striking manner.

We do not for a moment doubt that Mr. Burbank has "a broad intelligence and a sensitive soul." If he is also "as sweet, straightforward, and as unspoiled as a child," it is just possible that he can stand being told so. But his portrait is so singularly charming that it might have been left to speak for itself.

Text-book of Petrology, containing a Summary of the Modern Theories of Petrogenesis, a Description of the Rock-forming Minerals, and a Synopsis of the Chief Types of the Igneous Rocks and their Distribution, as illustrated by the British Isles. By Dr. F. H. Hatch. Fifth edition, revised and rewritten. Pp. xvi+404. (London: Swan Sonnenschein and Co., Ltd., 1909.) Price 7*s.* 6*d.* net.

THIS new edition of a well-known text-book for students marks a decided advance on its predecessors. It is clearly written, well illustrated, and has, as a rule, been brought up to date.

There is a brief but readable account of the eutectic theory of the process of crystallisation of igneous rocks, as well as of the different explanations which have been offered of the formation of porphyritic crystals.

The descriptions of the rock-forming minerals are in most respects accurate and sufficient. The author disclaims any intention of dealing with the optical determination of minerals, but as he makes use of the interference colours for the purpose of estimating the birefringence, he might with advantage have gone a little further and shown how easily an approximate quantitative determination of the relative retardation and birefringence may be made. Such expressions as "weak," "moderate," "very strong," "polarising in grey tints," "brilliant chromatic polarisation," though commonly employed, have very little scientific value, especially when the variation in thickness of rock-slices, even by good makers, is considered. In the same way, if the angle of extinction be employed for determinative purposes, the student should be taught to discriminate between the positive (slow) and negative (fast) directions of extinction. The statement that "between crossed nicols the rhombic pyroxenes extinguish of course straight" is too sweeping. Certain directions of section show quite an appreciable angle of extinction.

The author adopts analytical formulæ for the rock-forming minerals, a procedure which is justified by the clearness with which the composition is indicated and the ease with which it is remembered, but it may be noted that the abbreviation "Ab" for albite represents, not $Na_2O.Al_2O_3.6SiO_2$ as stated, but half that formula.

The primary classification of igneous rocks into plutonic, hypabyssal and volcanic, which is adopted, is sanctioned by almost universal usage, though it is as unreasonable as a fundamental division of the vegetable kingdom into roots, stems, and leaves. Each class of rocks is separated into families and types,